

## Alaskan Wild Berry Resources and Human Health under the Cloud of Climate Change<sup>†</sup>

JOSHUA KELLOGG,<sup>§</sup> JINZHI WANG,<sup>§</sup> COURTNEY FLINT,<sup>§</sup> DAVID RIBNICKY,<sup>#</sup>  
PETER KUHN,<sup>#</sup> ELVIRA GONZÁLEZ DE MEJIA,<sup>‡</sup> ILYA RASKIN,<sup>#</sup> AND  
MARY ANN LILA<sup>\*,§,⊗</sup>

<sup>§</sup>Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, Illinois 61801, <sup>#</sup>Biotech Center, SEBS, Rutgers University, New Brunswick, New Jersey 08901, <sup>‡</sup>Department of Food Science and Human Nutrition, University of Illinois, Urbana, Illinois 61801, and <sup>⊗</sup>Department of Food, Bioprocessing, and Nutrition Sciences, Plants for Human Health Institute, North Carolina State University, Kannapolis, North Carolina 28081

Wild berries are integral dietary components for Alaska Native people and a rich source of polyphenolic metabolites that can ameliorate metabolic disorders such as obesity and diabetes. In this study, five species of wild Alaskan berries (*Vaccinium ovalifolium*, *Vaccinium uliginosum*, *Rubus chamaemorus*, *Rubus spectabilis*, and *Empetrum nigrum*) were screened for bioactivity through a community-participatory research method involving three geographically distinct tribal communities. Compositional analysis by HPLC and LC-MS<sup>2</sup> revealed substantial site-specific variation in anthocyanins (0.01–4.39 mg/g of FW) and proanthocyanidins (0.74–6.25 mg/g of FW) and identified A-type proanthocyanidin polymers. *R. spectabilis* increased expression levels of preadipocyte factor 1 (182%), and proanthocyanidin-enriched fractions from other species reduced lipid accumulation in 3T3-L1 adipocytes. Selected extracts reduced serum glucose levels in C57BL/6J mice by up to 45%. Local observations provided robust insights into effects of climatic fluctuations on berry abundance and quality, and preliminary site-specific compositional and bioactivity differences were noted, suggesting the need to monitor this Alaska Native resource as climate shifts affect the region.

**KEYWORDS:** Anthocyanins; proanthocyanidins; *Vaccinium ovalifolium*; *Vaccinium uliginosum*; *Rubus spectabilis*; *Rubus chamaemorus*; *Empetrum nigrum*; traditional ecological knowledge; pref-1; adipocytes; diabetes; obesity; metabolic syndrome

### INTRODUCTION

Type 2 diabetes mellitus (T2DM) incidence rates in the United States have increased nearly 200% over the past two decades, rising from 5.6 million cases in 1980 to 15.8 million in 2005 (1). This has coincided with a surge in overweight and obese individuals; over two-thirds of the population of the United States is classified as overweight, with 32% of the population diagnosed as obese (2). American Indian/Alaska Native (AI/AN) populations suffer disproportionately high rates of T2DM and obesity and are twice as likely to have T2DM as non-Hispanic whites (1). This ethnic group has the highest obesity rates in all age classes (2, 3), which is in part attributed to a shift from a traditional to a more Western lifestyle, including higher calorie and fat diets (4) and lowered physical activity (5, 6). Alaska Natives are particularly at risk, experiencing increased glucose intolerance, T2DM, and obesity across all age groups (7–9).

Northern America sustains a wide range of berries that are integral parts of the traditional ecological knowledge (TEK) of

indigenous Arctic tribes. Salmonberries (*Rubus spectabilis* and *Rubus chamaemorus*), in the same genus as raspberry, have been used for such diverse health remedies as wound healing and gynecological aids (10), and both species are important to tribal populations as a foodstuff (10, 11). The Tanaina, a tribal group near Anchorage, AK, have used the leaves and stems of *Empetrum nigrum* (alternatively known as crowberry, blackberry, or mossberry in various regions of the Arctic) to treat diarrhea, and the plant is noted for countering kidney trouble (12). Highbush and bog blueberries (*Vaccinium ovalifolium* and *Vaccinium uliginosum*) are also integral dietary resources and are used both topically and orally as medicines (13). In addition to eating the raw berries, the Inupiaq (an Inuit people indigenous to Alaska's Northwest Arctic) also ferment them to prepare a vinegar for cooking and make berry-based relishes (14). Northern and Aleutian Alaska Natives also use the berries as part of agutuk, a traditional treat made with fish or seal oil (15).

Although scant phytochemical analyses have been documented for circumpolar berries such as those found in Alaska, significant circumstantial evidence suggests that they may be protective against diabetes-related health complications. Related berry species have demonstrated substantial bioactivity countering a

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\*Corresponding author [telephone (704) 250-5407; fax (704) 250-5409; e-mail maryann\_lila@ncsu.edu].